

that existed when the communication systems initiated sleep mode. By way of example, sleep mode may be initiated between CPE 100 and the communication interface 102.

Figure 2 illustrates a more detailed block diagram of an example embodiment of one configuration of the invention. Broadly, the elements of Figure 2 includes a transmit module 200 and a receive module 204. Connecting the transmit module 200 and the receive module 204 is a line interface 208 and other possible logic and lines (not shown). The line interface 208 connects the transmit module 200 and the receive module 204 to a communication channel 212. The line interface 212 includes apparatus to separate or filter the transmitted signal from the received signal and attempts to impedance match the transmit module 200 to the channel 212 and the receive module 204 to the channel. In one embodiment, the line interface 208 comprises a hybrid. The line interface 208 may also be configured to interface a single conductor of the transmit module 200 or the receive module 204 to twisted pair conductors. Although designed to reduce impedance mismatch, the line interface 212 often creates some mismatch.

In the example embodiment of the transmit module 200 shown in Figure 2, a sequence generator 220 connects to a PAM mapping module 222. The sequence generator 220 generates a sequence signal. The output of the PAM mapping module connects to one or more transmit filters 224. The transmit filters 224 provide the sequence signals to a digital to analog converter 226 and the output of the analog to digital converter connects to the line interface 208. A channel 212 connects the two line interfacing 208, 238.



With regard to the receive module, the line interface 238 is configured to receive and direct any received signals to an analog to digital converter 240. The output of the analog to digital converter 240 connects to one or more receive filters 242 and the output of the receive filters connects to a sequence correlator 246. The output of the sequence correlator 246 connects to a processor or comparator module 248, which in turn connects to a communication system 250.

### **Transmit Module**

The function of each element of the transmit module 200 is now briefly described with more emphasis on the elements that are of greater importance to the operation of the invention and which may not be as well known. The sequence generator 220 comprises any apparatus or system configured to generate a sequence signal for transmission over the channel 212. In one embodiment the sequence generator 220 comprises at least partly software. In one embodiment the sequence generator creates a maximal length sequence (M-sequence). In another embodiment the sequence generator 220 creates a Barker Code type sequence. In yet another embodiment, the sequence generator 220 creates a Kasami type sequence. In the embodiment shown in Figure 2 having a sequence correlator 246, it is desirable for the sequence to have good autocorrelation or cross correlation properties.

In one embodiment, the sequence generator 220 is embodied in a scrambler to generate a pseudorandom bit pattern or sequence in an attempt to output a data stream without long sequences of constant voltage values. Various different embodiments exist for generating a sequence signal.



The signal mapper 222 transforms the digital output of the sequence generator to any various signal levels that represent bit values. For example, four bits of digital data may be represented as 16 PAM, i.e. any of 16 different numerical values. The 16 different values may be represented on a scale of minus one to seven eighths in increments of 1/8. The signal may be scaled by an amplifier to yield a desired transmit power. In one embodiment the signal mapper 222 comprises a table look-up device or process that translates the binary input to a numeric output.

The transmit filter 224 is configured to manipulate the output data to adhere to desired or required spectral requirements. For example, frequency filtering may occur to improve system performance by tailoring the frequency content of the output or it may simply be mandated by FCC or a standards organization. It may be desired to attenuate out-of-band energy while also minimally effecting in-band energy. The embodiment shown in Figure 2 implements spectral shaping with a digital filter. An analog filter may serve to reject images of the digital processing. Another embodiment eliminates any digital transmit filter. In such an embodiment, the spectral shaping is provided by the analog filter.

The digital to analog converter 226 is generally understood to convert a digital signal to an analog signal. In the embodiment shown, the transmission on the line occurs in an analog format.

Although not shown, an analog filter may also be included just prior to the line interface 208 in the transmit module 200 to perform final filtering of the analog